Radiation Related Terms

Basic Terms

Radiation

Radiation is energy in transit in the form of high speed particles and electromagnetic waves. We encounter electromagnetic waves every day. They make up our visible light, radio and television waves, ultra violet (UV), and microwaves with a large spectrum of energies. These examples of electromagnetic waves do not cause ionizations of atoms because they do not carry enough energy to separate molecules or remove electrons from atoms.

Ionizing radiation

Ionizing radiation is radiation with enough energy so that during an interaction with an atom, it can remove tightly bound electrons from their orbits, causing the atom to become charged or ionized. Examples are gamma rays and neutrons.

Non-ionizing radiation

Non-ionizing radiation is radiation without enough energy to remove tightly bound electrons from their orbits around atoms. Examples are microwaves and visible light.

Health Physics

Health Physics is an interdisciplinary science and its application, for the radiation protection of humans and the environment. Health Physics combines the elements of physics, biology, chemistry, statistics and electronic instrumentation to provide information that can be used to protect individuals from the effects of radiation.

Radioactivity

Radioactivity is the spontaneous transformation of an unstable atom and often results in the emission of radiation. This process is referred to as a transformation, a decay or a disintegrations of an atom.

Radioactive Material

Radioactive Material is any material that contains radioactive atoms.

Radioactive Contamination

Radioactive contamination is radioactive material distributed over some area, equipment or person. It tends to be unwanted in the location where it is, and has to be cleaned up or decontaminated.

Common Types of Radiation

Gamma Rays

Gamma rays are electromagnetic waves or photons emitted from the nucleus (center) of an atom.

Betas

A beta is a high speed particle, identical to an electron, that is emitted from the nucleus of an atom

Alphas

An alpha is a particle emitted from the nucleus of an atom, that contains two protons and two neutrons. It is identical to the nucleus of a Helium atom, without the electrons.

Neutrons

Neutrons are neutral particles that are normally contained in the nucleus of all atoms and may be removed by various interactions or processes like collision and fission

X rays

X Rays are electromagnetic waves or photons not emitted from the nucleus, but normally emitted by energy changes in electrons. These energy changes are either in electron orbital shells that surround an atom or in the process of slowing down such as in an X-ray machine.

Common Units - USA

These are the common units used in the United States in health physics.

Roentgen (R)

The roentgen is a unit used to measure a quantity called exposure. This can only be used to describe an amount of gamma and X-rays, and only in air. One roentgen is equal to depositing in dry air enough energy to cause 2.58E-4 coulombs per kg. It is a measure of the ionizations of the molecules in a mass of air. The main advantage of this unit is that it is easy to measure directly, but it is limited because it is only for deposition in air, and only for gamma and x rays.

Rad (radiation absorbed dose)

The rad is a unit used to measure a quantity called absorbed dose. This relates to the amount of energy actually absorbed in some material, and is used for any type of radiation and any material. One rad is defined as the absorption of 100 ergs per gram of material. The unit rad can be used for any type of radiation, but it does not't describe the biological effects of the different radiations.

Rem (roentgen equivalent man)

The rem is a unit used to derive a quantity called equivalent dose. This relates the absorbed dose in human tissue to the effective biological damage of the radiation. Not all radiation has the same biological effect, even for the same amount of absorbed dose. Equivalent dose is often expressed in terms of thousandths of a rem, or mrem. To determine equivalent dose (rem), you multiply absorbed dose (rad) by a quality factor (Q) that is unique to the type of incident radiation.

Curie (Ci)

The curie is a unit used to measure a radioactivity. One curie is that quantity of a radioactive material that will have 37,000,000,000 transformations in one second. Often radioactivity is expressed in smaller units like: thousandths (mCi), one millionths (uCi) or even billionths (nCi) of a curie. The relationship between becquerels and curies is: 3.7×10^{10} Bq in one curie.

Common Units - SI - International Standard

Note: These are the common units used throughout the world in health physics.

Gray (Gy)

The gray is a unit used to measure a quantity called absorbed dose. This relates to the amount of energy actually absorbed in some material, and is used for any type of radiation and any material. One gray is equal to one joule of energy deposited in one kg of a material. The unit gray can be used for any type of radiation, but it does not't describe the biological effects of the different radiations. Absorbed dose is often expressed in terms of hundredths of a gray, or centi-grays. One gray is equivalent to 100 rads.

Sievert (Sv)

The sievert is a unit used to derive a quantity called equivalent dose. This relates the absorbed dose in human tissue to the effective biological damage of the radiation. Not all radiation has the same biological effect, even for the same amount of absorbed dose. Equivalent dose is often expressed in terms of millionths of a sievert, or micro-sievert. To determine equivalent dose (Sv), you multiply absorbed dose (Gy) by a quality factor (Q) that is unique to the type of incident radiation. One sievert is equivalent to 100 rem.

Becquerel (Bq)

The Becquerel is a unit used to measure a radioactivity. One Becquerel is that quantity of a radioactive material that will have 1 transformations in one second. Often radioactivity is expressed in larger units like: thousands (kBq), one millions (MBq) or even billions (GBq) of a becquerels. As a result of having one Becquerel being equal to one transformation per second, there are 3.7×10^{10} Bq in one curie.

SI Prefixes

Many units are broken down into smaller units or expressed as multiples, using standard metric prefixes. As examples, a kilobecquerel (kBq) in 1000 becquerels, a millirad (mrad) is 10^{-3} rad, a microrem (µrem) is 10^{-6} rem, a nanogram is 10^{-9} grams, and a picocurie is a 10^{-12} curies.

SI Prefixes						
Factor	**Prefix**	**Symbols**		**Factor**	**Prefix**	**Symbols**
10^{18}	exa	E		10^{-1}	deci	d
10^{15}	peta	P		10^{-2}	centi	c
10^{12}	tera	T		10^{-3}	milli	m
10^{9}	giga	G		10^{-6}	micro	µ
10^{6}	mega	M		10^{-9}	nano	n
10^{3}	kilo	k		10^{-12}	pico	p
10^{2}	hecto	h		10^{-15}	femto	f
10^{1}	deka	da		10^{-18}	atto	a

Terms Related to Radiation Dose

Chronic dose

A Chronic dose means a person received a radiation dose over a long period of time.

Acute dose

An acute dose means a person received a radiation dose over a short period of time.

Somatic effects

Somatic effects are effects from some agent, like radiation that are seen in the individual who receives the agent.

Genetic effects

Genetic effects are effects from some agent, that are seen in the offspring of the individual who received the agent. The agent must be encountered pre-conception.

Teratogenic effects

Teratogenic effects are effects from some agent, that are seen in the offspring of the individual who received the agent. The agent must be encountered during the gestation period.

Stochastic effects

Stochastic effects are effects that occur on a random basis with its effect being independent of the size of dose. The effect typically has no threshold and is based on probabilities, with the chances of seeing the effect increasing with dose. Cancer is a stochastic effect.

Non-stochastic effect

Non-stochastic effects are effects that can be related directly to the dose received. The effect is more severe with a higher dose, i.e., the burn gets worse as dose increases. It typically has a threshold, below which the effect will not occur. A skin burn from radiation is a non-stochastic effect.

For additional definitions, try:

- NRC's Nuclear Related Terms
- Health Physics Society's Radiation Related Fact Sheets and Terms
- Nuclear Science Terms (LBL)
- Rex Borders's Radiation Glossary

For more information on radiation, try:

- Radiation Information Network

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